Biodiesel in Washington: A Snapshot

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Summary

Biodiesel has captured the interest of Washington State citizens. For policy makers, biodiesel provides air quality benefits, including reductions in greenhouse gas and particulate emissions. Biodiesel also offers the promise of in-state production, which can improve energy security and create local jobs. For consumers, biodiesel offers an "environmentally friendly" alternative to petroleum diesel and opens up new market opportunities for fuel suppliers and farmers for services, commodities and products.

Since 2001, biodiesel consumption in Washington State has grown from a few thousand gallons to nearly 1.5 million gallons in 2004. While small in comparison to annual diesel sales of nearly 1 billion gallons, demand for biodiesel is continuing to increase and opportunities for market expansion are large. Currently, biodiesel sales are dominated by large public fleets, such as the City of Seattle and the Washington State Ferries. These fleets have been able to balance the higher cost of the fuel with its public benefits. However, as the cost of diesel increases, general interest in biodiesel is growing statewide. Currently, there are approximately 20 retail stations in the state selling biodiesel to both public and private customers.

To date, most of the biodiesel fuel being sold in Washington is imported from the mid-west and is produced from soybean oil. This situation is changing, however, as in-state production of biodiesel ramps up. The Seattle Biodiesel facility is the first commercial plant to manufacture biodiesel in Washington. The facility opened its doors in March 2005 and expects to produce from 1 to 2 million gallons of ASTM certified biodiesel during it first year of operation. When fully operational, Seattle Biodiesel will produce up to 5 million gallons per year given its current configuration. At this level of production, Seattle Biodiesel should be able to meet local demand over the next couple of years. Other biodiesel facilities are in various stages of development and may come on-line in the near future.

Although Seattle Biodiesel is currently importing out of state soybean oil to make biodiesel, efforts are underway to develop an oilseed market in the state. The creation of such a market is important to the long term success of an in-state biodiesel industry. Whether this happens will depend on the ability of Washington farmers to profit from the cultivation and sale of oilseeds. To date, the growing of oilseeds in this region has been fairly limited and estimated at less than 10,000 acres.

Growing oilseeds for profit will depend on a number of factors. Not the least of which is developing markets for the meal, which is the part of the seed that is left after extracting the oil. Some of the markets being explored for the meal include its use as a feed for livestock, an organic soil amendment, a bio-pesticide, or in the case of mustard meal, as mustard flour or powder for human consumption. Markets for glycerin, which is a by-product of the biodiesel manufacturing process, also need to be developed. New markets for glycerin include its use in the production of high value consumer products, such as Omega 3 fatty acids. The establishment of sustainable markets for these by-products is critical, as the economics of growing oilseeds cannot be supported through the sale of seed oil alone.

Background

Biodiesel is a mono-alkyl ester fuel made from vegetable or animals fats. Biodiesel can be blended with petroleum diesel fuel at any ratio; the most common blend rate is 20 percent biodiesel, 80% petroleum diesel, or "B20". Pure or neat biodiesel is called B100. Biodiesel is a domestically produced, renewable motor fuel which is non-toxic and biodegradable. The biodegradability of biodiesel is 4 to 5 times greater than petroleum diesel. B100 degrades 64% to 91% after 14-28 days. Diesel degrades only 15% to 18% over the same time period.[1] With respect to toxicity; biodiesel has gone through extensive testing and is often compared to table salt. Biodiesel is registered as a fuel and fuel additive with the U.S. Environmental Protection Administration (EPA) and has passed the EPA's Tier 1 Health Effects Testing under the Clean Air Act section 211(b).

Compared to conventional diesel, the use of biodiesel significantly reduces particulate matter (PM), carbon monoxide (CO), hydrocarbon (HC) and air toxic emissions. In their 2002 report, EPA reported an average PM reduction of 47% for B100 and 12% for B20 fuel.[2] EPA also reported an increase in nitrogen oxide emissions (a component in the formation of ozone or smog) of about 2% when burning soybean based B20 fuel. EPA also noted that alternative feedstocks, such as canola or mustard, may slightly reduce NOx emissions. NOx emissions can also be mitigated by using additives and by adjusting engine timing.

Biodiesel offers other advantages including improved lubricity and lifecycle energy and carbon benefits. Recent studies have shown that a 1% mixture of biodiesel fuel can improve overall engine lubricity by 65%, a valuable characteristic in light of upcoming federal regulations which require low sulfur diesel formulations.[1] Biodiesel also provides a net energy benefit when compared to petroleum diesel. According to an energy lifecycle study completed by the US Department of Energy, biodiesel yields 3.2 units of fuel energy for every unit of fossil fuel consumed in its production.[3] By comparison, petroleum diesel yields only 0.83 units of fuel energy per unit of fossil energy consumed. Because biodiesel is derived from vegetable oils, carbon is also recycled. As a result, biodiesel can reduce CO2 emissions by as much as 78% over petroleum diesel.

Policy Actions

Given biodiesel's promise, Washington State has passed into law specific incentives supporting an in-state biodiesel industry. In 2003, the Washington State legislature passed House Bills 1240, 1241, 1242 and 1243. The first two bills provide various tax incentives to encourage the development of in-state production facilities, distribution services and retail sales facilities for biodiesel and ethanol fuels. For manufacturer's, HB 1240 benefits include sales and use tax deferrals or exemptions; property and leasehold tax exemptions, and a reduced B&O tax. For distributors and retails suppliers of biodiesel and alcohol fuels, HB 1241 provides a B&O tax exemption and a sale and use tax exemption for certain investments in equipment and labor. HB 1242 encouraged state fleet use of biodiesel fuel, and 1243 directed a school bus biodiesel demonstration project.

Further state support for biodiesel was taken by Governor Gary Locke in the fall of 2004. At this time, Governor Locke signed Executive Order 05-01, which established sustainability and efficiency goals for state operations. As part of this order, state agencies are directed to replace standard diesel with a 20% biodiesel blend by September 1, 2009. The order also directed state agencies to begin using a minimum 5% biodiesel blend as soon as practical. Similar biodiesel initiatives have been embraced by other jurisdictions within the state, either through specific policy actions, such as the City of Seattle's Clean Fleet Action Plan, or through less formal fuel procurement requirements, such as the City of Tacoma's biodiesel purchase program. .

Current Biodiesel Use

Besides political support, interest in biodiesel is reflected in the growing demand for this fuel. In 2000, the City of Seattle was the only large fleet in the state investigating the use of biodiesel fuel for its fleet. Outside of Seattle, there were only small pockets of individual use, amounting to no more than a few thousand of gallons of fuel. Since then, the demand for biodiesel has grown tremendously. While exact consumption figures are unavailable, current use is estimated from 1 to 1.5 million gallons per year based on the frequency of biodiesel rail shipments into the Port of Tacoma.[4] This is an increase in biodiesel use of over 100% from the previous year. Table 1 shows some of the larger customers in the area and their estimated fuel use in 2004.

Table 1
Large Biodiesel Users in Washington State-2004

Major Consumers	Biodiesel (B100-Gallons)
City of Seattle	100,000
City of Tacoma	70,000
Mt Rainier National Park	34,000
State ferries	132,000
Dr. Dan's Alternative Fuel Werks	168,000
Intercity Transit	148,200
WA Military bases	111,000
King Co. Metro	96,000

Demand for biodiesel in 2005 is expected to rise. Most of the current public fleet users anticipate increasing their biodiesel use during this calendar year. It is also likely that other fleets will begin using biodiesel provided that biodiesel is priced competitively and that a consistent source of high quality fuel is available.

While the price premium for B20 has historically been reported at about $0.20 per gallon over diesel, the recent rise in diesel prices and the passage of favorable biodiesel tax incentives has narrowed this gap. In March 2005, the City of Seattle reported only a 2 cent price difference between the purchase price of B20 and ultralow sulfur diesel, their baseline fuel.[5] Implementation of the new federal biodiesel tax incentive ($1 per gallon for biodiesel produced from virgin oils, and $0.50 per gallon for biodiesel produced from recycled oils) is expected to further reduce the cost of biodiesel to consumers. ACME Fuels of Olympia, WA recently reported that they were selling biodiesel at a price below that of petroleum diesel, and credited the federal tax benefits as the reason for this price reduction.

Executive Order 05-01 should also help jumpstart state fleet use of biodiesel. State agency diesel fuel use is estimated at 36 million gallons per year. If agencies meet the 5 percent early adoption goal for biodiesel, state biodiesel use could reach 1.8 million gallons within the next couple of years. By 2009, state agency biodiesel demand could reach approximately 7.2 million gallons per year if current objectives are realized. In

anticipation of increasing demand for biodiesel by state agencies, the Department of General Administration recently added biodiesel to the state fuel procurement contract. The price for B100 is a pass through cost, with the bid margin increased by $0.02/gallon for transportation delivery

The Washington State Ferries (WSF) is using biodiesel in a few select boats operating in southern Puget Sound. More than 132,000 gallons of biodiesel were burned during a 2004 pilot test.[6] By comparison WSF currently consumes about 18 million gallons of diesel fuel per year. The WSF anticipates continuing the pilot study during 2005 and expanding it to additional boats provided they can work through some fuel quality problems they have experienced using biodiesel. WSF is currently working with the University of Idaho to identify and correct these problems.

To date, the use of biodiesel has been dominated by large public fleets, as they have been more willing to pay a premium price for the fuel than have private fleets. However, there is a growing demand by the general public to fuel their vehicles and boats with biodiesel. Although the retail sale of biodiesel is not tracked separately from other fuels, the sheer growth in biodiesel fueling infrastructure provides anecdotal evidence that this market sector is increasing. The National Biodiesel Board currently lists 17 biodiesel distributors in Washington State and 20 retail stations selling biodiesel fuel. In addition, there are a number of biodiesel cooperatives active in the state and supplying their members with biodiesel. Further evidence of the increasing popularity of biodiesel fuel is indicated by sales from Dr. Dan's Alternative FuelWerks, a Seattle based wholesale/retail fuel outlet which sells fuel to the general public. In 2004, Fuel Werks sold approximately 168,000 gallons of B100.[7] FuelWerks is expecting to expand their retail operations over the next year as demand for the fuel continues to increase.

Overall, the market demand for biodiesel appears strong and the opportunity for growth remains high, particularly if diesel prices continue to stay at current levels. Table 2 shows total diesel sales in the state for 2002, and the portion of sales that could be captured by biodiesel, assuming a 2 and 20 percent market penetration rate. In looking at just on-highway diesel sales, the potential market for B2 and B20 fuel approaches 11.4 million gallons/yr and 114 million gallons/yr, respectively.

Table 2
Washington State Biodiesel Sales Potential

	2002 Diesel Fuel Sales (Thou.Gal.)	Potential Biodiesel Market	
		B2 Blend (Gallons)	B20 Blend (Gallons)
Commercial	41,775	835,500	8,355,000
Electric Power	412	8,240	82,400
Farm	30,661	613,220	6,132,200
Industrial	21,182	423,640	4,236,400
Military	90,383	1,807,660	18,076,600
Off-highway	62,946	1,258,920	12,589,200
Oil Company	657	13,140	131,400
On-Highway	570,344	11,406,880	114,068,800
Railroad	51,541	1,030,820	10,308,200
Residential	68,556	1,371,120	13,711,200
Vessel Bunkering	51,090	1,021,800	10,218,000
Total	**989,547**	**19,790,940**	**197,909,400**
Source: Energy Information Agency			

Biodiesel operational issues

Overall, consumer experience using biodiesel has been positive. However, along with the Washington State Ferries, other fleets, including some school districts, have experienced limited problems when fueling with biodiesel. These problems included clogged fuel filters, fuel injector pump problems and engine stalling. Some of these cases can be traced to poor quality fuel, while others may be the result of fuel handling problems. Because of its inherent solvent properties, there can be some material compatibility issues when handling biodiesel. In older engines, rubber seals and hoses should be replaced as they will degrade after prolonged exposure to biodiesel. Fuel filters should also be checked when first using biodiesel as they may become plugged with accumulated sediments resulting from biodiesel operations. Similarly, onsite fuel storage tanks should be thoroughly cleaned prior to accepting biodiesel to avoid fuel contamination issues. To ensure proper handling and storage, consumers should refer to the Department of Energy

publication “Biodiesel and Handling and Use Guidelines” which can be viewed at http://www.afdc.doe.gov/altfuel/bio_papers.html.

To help ensure fuel quality, the American Society of Testing and Materials, the U.S fuel standard-setting body, has developed Specification D 6751 which applies to all biodiesel bought and sold in the U.S. Consumers purchasing biodiesel should demand that the fuel they are purchasing meets this specification. In addition, the National Biodiesel Accreditation Program has started up a voluntary program for the accreditation of producers and marketers of biodiesel fuel called BQ-9000.[8] The program is a unique combination of the ASTM standard for biodiesel, and a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.

Finally, consumers should be aware that engine warranty issues are not directly impacted by biodiesel use. Diesel engine manufactures warranty their engines based on materials and workmanship. No engine warranty covers fuels. Engine manufacturers have developed recommendations for biodiesel use; however, which varies from manufacturer to manufacturer. This information can be viewed at http://www.nbb.org.

Production

While the demand for biodiesel fuel is growing, in-state production of biodiesel has been more elusive. A number of biodiesel production facilities have been proposed over the last few years, but until recently, the only in-state production of biodiesel has been by small, independent producers for personal use. This situation has changed with the start-up of Seattle Biodiesel’s 5 million gallon-yr facility located in Seattle, Washington. The facility began producing biodiesel in March, 2005 and expects to produce from 1 to 2 million gallons of biodiesel during its first year of operation, ramping up to 4 to 5 million gallons as the market grows.[9]

The start-up of the Seattle Biodiesel plant provides a tremendous boost to an in-state biodiesel industry. Whether this industry grows, however, is yet to be determined. As of now, Seattle Biodiesel is importing soybean oil from out of state to make its biodiesel. As a result, any competitive advantage realized by a reduction in transportation costs for the oil is lost. Importing oil into the state from the Midwest is estimated at about $0.20/gallon. While Seattle Biodiesel expects to be competitive with out-of-state biodiesel producers, the ability of Seattle Biodiesel and other in-state producers to source lower cost, in-state oil feedstocks is important to their long-term success.

Waste oils and grease

Oil feedstock for a biodiesel plant can come from both waste oil and grease, and/or from oilseed crops. The collection and reuse of waste food oils, tallow, lard and other fats and greases is primarily controlled by the rendering industry. These waste products have a commodity value, largely as animal feed, which on average trades at $0.07 to $0.16 per

pound. A biodiesel production facility would need to compete with this market and offer a stable and competitive price for the use of this feedstock.

The amount of waste grease and oil generated in Washington State is uncertain as information on its collection and processing is largely proprietary. The National Renewable Energy Lab estimates that that an average of three gallons of waste oil is generated per person, per year. Given a population base of approximately 6.1 million people, Washington State citizens would generate about 18.3 million gallons of waste oil per year. This value probably represents the upper bound of supply, as other estimates assign a lower value of 1 to 2 gallons of waste oil per capita. In any event, there is a finite supply of waste oil and the amount that could be available for use as a biodiesel feedstock will be determined by competing market conditions.

The activities of Baker Commodities, a large national rendering company operating in Washington State, may provide some insight into this market. The company has control over a significant portion of the waste oil and grease stream in Washington State and has been considering developing a 6 to 10 million gallon per year biodiesel plant near its Tukwila facility.[10] The decision to build a plant is pending the outcome of design testing and plant economics. Baker Commodities has been evaluating this project for almost 3 years, indicating that the economics of such a facility are not without risk.

Oilseeds

While waste grease and oils may provide a viable feedstock for biodiesel production, the key to developing a sustainable biodiesel industry in the State lies in the cultivation of oilseeds, or *brassicas*, which includes canola, rapeseed and mustard. Whether investment in oilseed crops occurs will depend on farmers being convinced that the market is stable, that the cultivation of these crops fits within their crop management scheme, and that in growing these crops, they will make money.

While it is beyond the scope of this review to assess the economic viability of growing oilseed crops, some general observations can be made. One, oilseeds such as canola, rape and mustard are generally not grown as primary crops, but can be used as a rotational crop in the cultivation of wheat or other grains. Farmers evaluate oilseeds profitability against other rotational crops. To plant oilseeds, a farmer must be convinced that the economic returns for these crops are at least as good as other alternatives.

There have been numerous studies looking at the *break-even price* (the level at which returns cover growing expenses) for canola and mustard. While the wide variability in seed yields will cause this price to swing, a generally accepted break-even price is 13 to 15 cents/lb.[11] Assuming an oil content of 42% and a 90 percent extraction rate, approximately 20 lbs of seed will yield one gallon of oil, which is roughly equivalent to one gallon of biodiesel. At a price of 15 cents/lb for the seed, the cost of the oil is about $3 per gallon, not counting crushing costs, which could add another $0.30 to $0.50 per gallon. Even before adding a biodiesel production and distribution cost, this price exceeds the current sale price of B100.

As shown, the economics of growing canola or mustard as a feedstock solely for biodiesel use does not make sense. Instead, the value of oilseeds as a biodiesel feedstock depends upon a number of factors:

- value of fossil diesel;
- value of tax incentives;
- value of seed meal;
- value of glycerol (a co-product of biodiesel production);
- cost of crushing oilseed; and
- cost of processing seed oil into biodiesel.

While all of these factors are important, the development of higher value seed meal markets may be the most significant, for without this, farmers are unlikely to invest in oilseed crops. Currently, there is a lot of work in the region looking at how to improve the market for seed meal-from increasing the value of the meal as an animal feed, to exploring new markets, including the use of the meal as a soil amendment, a biopesticide, as food for human consumption, or as a feedstock for other bioproducts. In particular, mustard seed is receiving increased attention because of its value as a rotational crop and in direct seed applications. In addition, mustard seed can provide high oil yields and offers the promise of new markets for the meal.

The University of Idaho has been at the forefront of developing new strains of mustard seed and investigating markets for the meal. One promising market is to use the defatted meal as an organic pesticide. While this market remains largely undeveloped, it offers the promise of a high value market for the meal. If realized, the value of the remaining mustard oil is projected at 10 cents per pound, allowing for biodiesel production costs of $1.00 per gallon, according to the U.S. Department of Energy. Other markets for mustard meal include its use as a flour or powder for human consumption. While these markets are new to the Northwest, they offer high value and may provide farmer's with the necessary incentives to invest in this industry.

Tax incentives also factor heavily in the economic viability of biodiesel production. The Commodity Credit Corporation of the U.S. Department of Agriculture provides grants for the expansion of biodiesel production. In the past these grants have been as high as $1.43 per gallon of virgin oils for additional production capacity, effectively reducing the variable cost of virgin oil biodiesel by $1.10 per gallon. The continued availability of this credit is uncertain as it depends on Congressional appropriations. The U.S. Congress also approved a biodiesel tax incentive in 2004, which provides a tax credit of $1 per gallon for biodiesel made from virgin oils and $0.50 per gallon for biodiesel made from recycled oils and other fats and greases. This credit is set to expire on January 1, 2007.

Glycerin

In addition to a strong meal market, a market for glycerin is important. The National Biodiesel Board indicates that the biodiesel industry gets about 70% of its revenue from

biodiesel and 30% from glycerin.[1] About three-quarters of a pound of glycerin is produced for every gallon of biodiesel made. For a 10 million gallon per year plant, about 3,750 tons of glycerin is produced annually.

Glycerin can be sold into the oleochemical industry where it used to make a variety of consumer goods, including soaps. However, this market is saturated, and according to a February 2005 Chemical Engineering and News report, the price for glycerin has plummeted from $1 per pound a couple of years ago, to less than 50 cents per pound today.[12] This price drop is blamed on the recent increase in biodiesel production and is not expected to rebound anytime soon.

As a result, new markets for glycerin need to be developed. Among others looking at new glycerin markets, Washington State University is investigating alternative markets and has begun research into the production of higher value products from glycerin, including succinic acid and Omega 3 fatty acids. Support for this effort and for research and development of other end-use markets for glycerin will help improve the overall economics of producing biodiesel.

Potential Integrated Oilseed/Biodiesel Projects

Hal Collins, USDA Agricultural Research Service-Prosser, is currently conducting oilseed variety trials in southeast Washington State to evaluate yield potential from various oilseed crops. Based on this work, Dr. Collins estimates that 44,334 acres of Garnet variety spring rapeseed, or 56,862 acres of Pacific Gold spring mustard would be needed to support a 5 million gallon per year (MGY) biodiesel facility.[13] The acreage needed to support a 5 million gallon per year facility would more than double for non-irrigated oilseed crops.

The University of Idaho recently prepared a preliminary assessment of oil production potential for the inland NW (Benewah, Kootenai and Latah Counties, Idaho, and; Adams, Lincoln, Spokane and Whitman Counties, Washington). This assessment indicated biodiesel production yields of 17.8 million gallons to more than 27.4 million gallons, given an oil production potential of 47 to 73 gallons per acre, respectively.[14] If realized, this represents from 3% to 5% of on-highway diesel sales in Washington State during 2002.

Dennis Roe, Crop Scientist with USDA-NRCS in Pullman, WA provided another estimate of oilseed potential for the region.[15] Dr. Roe estimated that there is about 6.375 million acres of potential crop land (rainfall in excess of 8 inches per year) in southeast Washington, northeast Oregon and north central Idaho. Of this amount, approximately ¾ of the land (4.78 million acres) is either fallow or recrop land which could support some level of oilseed production. An ambitious estimate assumes that 1/5 of this land could be put into oil seed production, while a conservative and possibly more realistic estimate assumes that about 1/16 of the land is available at any one time for oilseed production. Given these estimates, the potential acreage for oilseed production in the region would

range from 298,830 acres to 956,000 acres and could produce from 21.8 million gallons to 69.8 million gallons of oil, assuming an oil yield of 73 gallons per acre.

The amount of actual acreage farmers reserve for oilseeds will depend on a number of factors including oilseed prices, government incentives, co-product markets, crop rotational requirements, set-asides, access to local crushers, farmer preference and participation, and weather. By comparison, Dr. Jack Brown of the University of Idaho estimated that there was less than 10,000 acres of oilseeds under cultivation in this region in 2004.[15]

One model, that may prove successful in moving the biodiesel industry forward, is taking place in Spokane, Washington. Palouse Bio LLC, representing the six major agricultural coops in Spokane and Whitman counties with some 2500 member farmers, is pursuing funds to own and operate their own crushing facility and potentially, a biodiesel plant. According to Jim Armstrong of the Spokane Conservation District, the co-ops have identified high value markets for edible mustard powder or flour.[16] The financial model the co-ops assembled show that at a value of $450 per ton for the meal, the cost of the oil is virtually free.

At this point, the co-ops anticipate a market price for mustard meal higher than this threshold. If these markets hold true and can be sustained over time, the cost to manufacture biodiesel could drop below $1.00 per gallon, including ROI and all debt servicing and overhead/profit. In its current proposed structure, the co-op crusher could generate about 2.5 million gallons of oil annually.

A similar co-op structure is also being investigated in southeast Washington. The Columbia/Blue Mountain Counties Farm Bureau recently formed a new business called Pacific AgriEnergy, LLC. The group completed a feasibility study in November, 2004 which looked at the viability of creating an integrated oilseed extraction and biodiesel/ bioproducts production facility. The study estimated about 120,000 tons of *brassica* oilseeds (both mustard and canola) could be locally produced. In turn, the facility would be capable of producing about 10 million gallons of biodiesel, 80,000 tons of oilseed meal and approximately 3,750 tons of glycerin.

The project feasibility study identified sufficient markets to support a feedstock pricing structure that meet's the grower's income requirements and should encourage regional farmers to participate in contract oilseed production. The LLC has completed a business plan, which remains proprietary at this time, and is currently engaged in developing project financing alternatives.

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Further Information on Biodiesel

The National Biodiesel Board-http://www.biodiesel.org/

University of Idaho Biodiesel Program- http://www.me.iastate.edu/biodiesel/

NREL Biodiesel Handling and Use Guidebook-
http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/tp36182.pdf

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http://www.nrel.gov/docs/legosti/fy98/24772.pdf

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